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ABSTRACT

This paper reviews critically four studies on teacher thinking as conducted at the Center for Instructional Psychology, University of Leuven, Belgium. The four empirical studies were: (1) a process analysis of teaching; (2) subjective problems of student teachers while teaching; (3) context variables during lesson planning; and (4) post-interactive reflections of teachers. The critiques present discussions on the following elements of the studies: (1) data from the literature; (2) data from the descriptive-empirical research; (3) research methodology used in the study; and (4) results. Included in the discussion are analyses of the cognitive processes of teachers in the pre-active (planning) phase, the interactive phase; and the post-interactive phase of teaching a unit of study. A discussion is presented of results of the four studies grouped into categories: (1) substantial results; (2) methodological questions; and (3) theoretical value of the studies. Seven pages of references are included. (JD)

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TEACHER THINKING : A CRITICAL ANALYSIS OF FOUR STUDIES

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Paper presented in an invited symposium on "Teacher Thinking: current studies and critics" organized by J.Lowyck & R. Halkes (ISATT) at the Annual Meeting of the American Educational Research Association, San Francisco, April 16-20, 1986.

Introduction

The empirical studies on teacher thinking steadily increased during the past decade (see e.g. Shavelson & Stern, 1981; De Corte & Lowyck, 1983; Lowyck, Peters & Tillema, 1985; Clark & Peterson, 1985).

Although the "criterion-of-effectiveness" paradigm (Gage,1963) was dominant in the sixties and early seventies, some scholars in the field opened new ways for research on teaching. They often cracked the solid walls of the reductionistic process-product studies and introduced new concepts and models. A striking example is the study of the pre-interactive phase of teaching which resulted in an interesting description of the covert aspects of teaching. Other researchers constructed cognitive oriented models of teaching. Still others paid attention to the influence of the context on teaching activities. The shift to the new paradigm was publicly aknowledged by the research community in the final report of panel 6 at the National Conference on Studies in Teaching, organized by the N.I.E. and published in 1975 : Teaching as clinical information processing. The impact of this theoretical framework on researchers is perceptible in many studies during the last ten years.

The four studies briefly reported below are in line with research on teacher thinking although they started differently. Our investigation of cognitive processes in teaching resulted from the redirection of an experimental study in the field of teacher education.

After a period of research with microteaching, looking at teaching as a limited set of discrete behaviors, we in 1975 shifted to a more integrative approach which has been identified afterwards as the cognitive one. The concept of teaching used in the microteaching studies was a restricted one and in no way dealing with both the complex teaching activity and the context. Because it seemed necessary to explore the complexity and intentionality of teaching, the cognitive processes of teaching were investigated (Lowyck,

1978; 1980). The outcomes of this first study were used a platform for further research as will be reported below.

1. A process analysis of teaching (Lowyck, 1980)

To provide a sound theoretical basis for a descriptive-empirical investigation into the cognitive variables of teaching, the literature on teaching until 1978 was first explored and grouped into three topics: (1) ccncepts, (2) models and (3) research on teaching and teaching skills. The outcomes of this study together with the more specific research purposes led to a descriptive-empirical investigation.

1.1. Data from the literature

The literature has been scanned on three topics, namely the definitions, models and research approaches of teaching and teaching skills.

The analysis of the definitions of teaching was not very clarifying (Lowyck, 1979). On the one hand, empirically oriented researchers seldom define teaching clearly and unequivocally (see e.g. Lumsdaine, 1963; Corey, 1967; Skinner, 1968; Amidon & Hunter, 1969; Flanders, 1970), while on the other analytic philosophers of language in their description of teaching through the semantic meaning of concepts mostly lack contact with empirical research (Scheffler, 1968; Komisar & Nelson, 1969; Hirst, 1971, e.a.). Insofar as teaching skills are concerned, a satisfying elaboration of this concept is not apparent in the educational literature.

Cognitive models of teaching appeared sporadically in the literature. An explanation can be found in the emphasis on observable and measurable instructional behaviors in the sixties and early seventies. A limited number of cognitive models were brought to light, although they were not founded

on empirical research (Coladarci, 1959; Gage, 1972; Ryans, 1963; Shavelson, 1973; Snow, 1970; Stolurow, 1965; Strasser, 1967). On the contrary, the psychological models of skilfulness were well elaborated although they mostly referred to the psychomotoric domain (see e.g. Bartlett, 1963; Fitts, 1965; Welford, 1965; Whiting, 1975). It is only through extrapolation that these studies can be linked with teaching skilfulness (Lowyck, 1980).

As far as research is concerned, it is only after 1975 that empirical studies are focused on the cognitive processes of teachers during the pre-interactive, interactive and post-interactive phase of teaching. Some previous studies show an affiliation with the cognitive approach, using descriptive methods, such as ethnography (Smith & Geoffrey, 1968; Hamilton & Delamont, 1974), participation and systematic interview (Jackson, 1968), educational connoisseurship and criticism (Eisner, 1975), and process tracing (Snow, 1968; Shulman & Elstein, 1975). It is in a later stage that use is made of thinking aloud, stimulated recall, logbook keeping, etc.

Teaching has been approached mostly from an a priori reduction imposed by the researcher. How the teacher herself functions with respect to the intentionality and complexity remained out of consideration. The reported state of affairs in 1975 with respect to the study of cognitive variables in teaching led to a descriptive- empirical project which more deeply penetrated into the cognitive processes during the pre-active and interactive phase of teaching.

1.2. Data from the descriptive-empirical research

The study was conducted during the second half of 1976. At that time the first results of empirical research on teacher thinking have been reported in the literature (Clark & Peterson, 1976; Shavelson, Cadwell & Izu, 1977).

1.2.1. Method

Subjects

The sample was restricted to sixteen experienced teachers (8 men, 8 women) in the fifth grade of primary schools. They were selected as 'good' teachers by their inspector while the investigator expected to trace some important characteristics of skilful teaching. They differ with regard to their teaching experience, familiarity with fifth grade pupils, age, size and composition of the class as well as the type of school.

Procedure

To guarantee the necessary comparability of the material, each teacher was asked to plan and execute one lesson on each of the following topics: "We paint our classroom' for arithmetic and "The consequences of the long dry summer on the price of a noon meal", as a theme of economic geography. In order to maintain the teaching situation as natural as possible, topics were sought which could be perceived by teachers and pupils as meaningful and were close to the curriculum.

The lesson plans as well as the written commentary on some decision points were submitted before the lesson took place. Each lesson was video taped. In order to gain insight in the possible distortion of the daily situation, after each lesson the pupils were given a short questionnaire to record perceptions of reality distortion. The teacher was asked to do the same after both lessons.

A retrospection session was organized as soon as possible after the two lessons. Reflections about the planning of lessons came first. Thereafter, the video lessons were viewed and the teachers could indicate the retrospection points expecting that they would reveal the most important or critical aspects.

The materials thus gathered consisted of the written lesson plans, the retrospection on the planning, the video-taped lessons, the lesson protocols and the protocols of the retrospection. In order to cover the relevant material, a recurrent, cyclical analysis was used. As a measure of the reliability of the information, retrospection statements from the teachers were confronted with lesson plans and protocols. In some cases, a discontinuity between retrospection information and the external analysis appeared. At the end, the material was classified into three categories: the planning, the execution and the relation between both.

1.2.2. Results

One of the main difficulties in reporting qualitative data is the indication of their relative importance, which cannot be deduced from the frequency of statements. A teacher saying only once that subject matter is the "most important" variable in her planning, reveals subjectively the strongest planning factor. Therefore, results are often illustrated by literal statements.

The pre-active phase

The written lessons plans as well as the retrospection on the planning enabled a precise reconstruction of the planning process (see Lowyck, 1980). Some results are noteworthy. First, each teacher planned through succesive steps but in a cyclical way: inspection of the assignment, acquisition of the content by the teacher, determination of the content for the pupils, organization of the lesson, definite lesson plan. Second, in each step two different types of behavior occurred: routines and problem solving. Third, lesson plans were different, from very detailed to sketchy. The way of planning determined the degrees of freedom during the lesson. Teachers with a well elaborated and detailed plan were less flexible in their interaction, while open planners often structured less during the lesson.

Teachers continuously process external and internal information during planning.
External information is: the assignment, the subject, the entry situation, the objectives, the methods, the media and even the research situation. Internal input consisted of the experiences teachers, their familiarity with the pupils, the knowledge of subject matter and its sequencing principles, the repertoire of teaching activities and the expectations toward the researcher. Cognitive processes were: selective perception of external and internal information, interpretation of data, decision making, problem solving, anticipation and information storage.

The interactive phase

The description of the cognitive processes during this phase was based upon two types of reflection: video taped lessons (concrete retrospection) and free recall (broad retrospection). The teachers indicated themselves the retrospection points. It was expected that this procedure would reveal the most interesting cognitive variables. However, contrary to the planning phase where the different steps were described, the video retrospection was directed to discrete moments. The flow of the lesson was continually interrupted and as a consequence the relation between successive events and the underlying cognitive processes was missed. The results of this kind of retrospection, then, had to be classified into three separate categories: the internal input, the external input and the cognitive processes.
The internal input mainly covers the expectations of the teacher toward the level of participation of the pupils, the suitability of the lesson content and the stored lesson plan. External input is seldom reported and if so, it concerns the interactive reactions of pupils and the perception of salient environmental features.
The information processing activities are: perception, interpretation, storage of information, anticipation and decision making. These processes are not worded by the

teachers, but are inferred from their daily vocabulary such as: see, notice, look ahead, remember, etc.

The relation between planning and execution

The comparison between both phases of teaching can take place in two different ways. First, the researcher can compare the different data from both phases, Second, the teacher can deliver direct information about the continuity or discontinuity between plans and interactive behavior. Both information sources have their own inconveniences. The former procedure does not enable the researcher to cover all the data from each phase: the process analysis of the planning phase shows little correspondence with the discrete data from the interactive setting. The latter procedure runs the risk of a contamination between both phases, because the retrospection took place after the planning and execution. Therefore, the retrospection of the teacher was used as the first information source but it was controlled by an external analysis of both the written lesson plans and the lesson protocols.
The following conclusions have been drawn. First, the nature of the cognitive processes differed in both phases. The teacher took a lot of external information into account when preparing lessons, while it was almost exclusively restricted to the pupil reactions during the interactive phase. A similar observation applied to the cognitive processes. Decision making and problem solving were frequenlty mentioned during the planning and very seldom in the interactive phase. Second, the teachers revealed mostly the discontinuity between both phases, because they better remembered the instances where the reality differed from the preparation. Sometimes, a confusion between both phases was apparent. What a teacher defined as "spontaneous" interactive behavior, seemed to be well prepared during the planning as appeared from the external analysis of data. Third, the external analysis compared with the retrospection showed a lot of detailed information and revealed besides the discontinuity also the continuity between planning and execution.

2.Subjective problems of students teachers while teaching

One of the results from the research mentioned above, is the difference between routines and problem solving activities in teaching. In order to gain more insight into the reasons why (student-) teachers experience problems, a specific project has been elaborated. Because it seems more difficult for experienced teachers to report the problematic aspects of their already automated teaching activities, student teachers have been selected as a sample. In order to compare the results with the ones from the first project, the same categories are used, namely the planning, execution and the relation between both phases. A possible disadvantage of this design is the lack of testing or revising the categories already established.

2.1. Data from the literature

In the educational literature, the concepts 'problem' and 'problem solving' are often defined in a diverging way.
A problem refers to a situation in which a subject is confronted with a gap between the reality and a desirable goal, which has to be bridged even when the uncertainty about the effects is still there (see e.g. Miller, Galanter & Pribram, 1960; Newell & Simon, 1972).
A problem is determined by the structural components of the situation. Newell & Simon (1972) distinguish between the task environment and the problem space. The former contains more objective features, while the latter is the selective transposition of some environmental aspects into a subjective framework.
As to the teaching situation, a peculiar difficulty is apparent. Contrary to tasks in psychological experiments on problem solving, where almost all the components of the environment are defined by the researcher, teaching remains a complex activity and depends largely upon philosophical conceptions about 'good teaching'. Consequently, the task environment is not unequivocal and it still remains

difficult to describe its reduction into the problem space of an individual teacher. Therefore, it seems more adequate to start from a study of the problems as perceived by teachers to gain insight into the main components of the teaching task.
Although some problem-solving models of teaching were at hand (see e.g. Fattu, 1965; Fuller, 1969; Turner, 1964) they were not supported by empirical data, contrary to psychological studies on problem solving with a vast amount of research evidence. Moreover, most studies were not focused on 'teaching' problems during the planning and excecution, but on 'teacher' problems on the micro-, meso- and macro-level of functioning. Well known in this respect are the problems of beginning teachers (Veenman, 1984).

2.2. Data from the descriptive-empirical research

The outcomes of the search in the educational literature emphasized the necessity for an investigation of subjective problem experiences in teaching.

2.2.1. Method

Subjects

Fourteen female student teachers from six classes in an institute for primary school teachers participated at the study. The limitation to one institute and to an exclusively female group was the consequence of practical decisions.

Procedure

As was the case in the first study, both concrete and broad retrospection on the planning and execution are used. The lesson topics were free, meaning that the research should not disturb the ordinary lesson table. As a consequence, a fan of lesson topics was available, such as geography, arithmetics, music, mother language, grammar, and social studies.

The students were asked not only to write down their lesson plans in a normal way, but to indicate at the same time the perceived problems. The lesson was videotaped and afterwards recorded in protocols. During the lessons, the teacher educator took notes, mainly to identify supposed problems in the teaching activity of the students. Immediately after the lesson, students were invited to signalize experienced problems. This type of retrospection however was of little use, because the students showed great tension, failed a view on the whole lesson and had difficulties in organizing the flow of confusing impressions. The extensive retrospection sessions which took place some days later delivered more interesting information. The session was audio recorded and transcribed on protocols. The videotapes were viewed and evaluated by the teacher educators. This information together with their classroom notes was used as an external source of problem detection.

2.2.2. Results

As already has been mentioned, the results are reported in the same categories as was the case in the first study.

Problems during the pre-interactive phase

The results showed possible problems in each step of the planning process. Contrary to experienced teachers, student teachers report many external sources of their problems. Some teacher educators, for instance, were very directive in their task assignment which caused in the student teachers a tension between adaptation and originality . Others allowed so much freedom that the student teacher lacked any hold. Other problems were : deficient information about the developmental stage of the pupils or of their foreknowledge, lack of rules for classroom management, insufficient strategies for chosing and sequencing lesson content, uncertainty about the time sheduling and inefficiency in the choice of examples relevant for the pupils. In brief, the shortage of knowledge about the pupils was one of the main problem sources.

Problematic aspects of planning also depended upon some aptitudes of student teachers, like achievement motivation, self esteem or anxiety. Although many student teachers were aware of their problems, they did not have a sufficient insight in the causes and consequently in the solutions. Sometimes, problems were perceived but set aside to take the next steps. This neglect of problem solving activities created oftentimes serious problems during the interactive phase of teaching.

Problems during the interactive phase

Because the student teachers could choose the retrospection points, again a precise process analysis was not possible. The discrete aspects of the reflection were grouped in the following classes: classroom management, interaction quality and personal characteristics of student teachers.
In the classroom interaction, mostly the same problems are reported as was the case for the planning phase, although they had a different emotional load. Indeed, the perceived problems were no more hypothetical nor rational, but very visible for both student teachers and pupils. Examples are amongst others: insufficient control over the lesson content, incapacity for answering pupils' questions and hesitations with the lesson structure. Student teachers mostly solved problems on a strategic and no substantial way ignoring the problem, postponing the solution or throwing the problem back to the pupils. The student teachers often became aware of the problem when the pupils made it visible in their reaction and not on the ground of intrinsic criteria.
Problems with the interaction quality were less frequently reported. Maybe the research situation functions was a buffer for possible troubles, like aggressive or disturbing behaviors.
Some student teachers revealed problems with more personal aspects, for example attitudes, non-verbal behavior, language accent or wording. Maybe the video retrospection overemphasized these and caused a ' cosmetic effect' (Fuller & Manning, 1973).

Problems in the relation planning- execution

The discrepancy between the pre-interactive and the interactive phase was perceived by the student teacher as a real problem. Examples are: the lack of mastery of lesson content, some unintended change of the lesson structure, the stay out of expected pupil reactions, a wrong estimation of the entry level, and the inadequate timing. As already has been mentioned, some of the problemed resulted from a careless preparation and a conscious neglect of problems during the planning phase or originated because the student teacher clinged too close to the lesson plan or lacked a well elaborated structure.

3. Context variables during lesson planning

In the study of teaching, some researchers have paid attention to the influence of the educational context on teaching activities (see e.g. Doyle, 1977; Hamilton & Delamont, 1974; Jackson, 1968; Smith & Geoffrey, 1968). Moreover, the preceding study reports an important impact of the teaching situation on problem experiences in student teachers. It seemed thus interesting to investigate the influence of context variables on lesson planning. The preparation of lessons is conceived of as processing external and internal information in view of future behavior. The context is the source of external information a teacher processes which in no way means that all the variables in the environment can be influenced by the teacher. Indeed, the number of pupils, their socio-economical background, the school type, the parents all restrict the possible decisions of teachers.

3.1. Data from the literature

Teachers during their planning are continuously confronted with several aspects of the teaching environment. Clark &

Yinger (1980) mention three main categories: the pupils, the curriculum and the broader teaching context. This classification was useful to explore the literature on teacher planning. More than twenty studies were analyzed and the different context variables indicated. The results are reported in Table 1.

Insert Table 1. here

The teacher more or less influenced future teaching through her plans, selecting or leaving out of consideration particular information. It is thus important to detect the way teachers handle information during the pre-interactive phase of teaching in order to understand more fully their interactive behavior.

3.2. Data from the descriptive- empirical research

This investigation aims at the identification of the context variables a teacher takes into account when preparing lessons. However, the focus is not on the context variables which influence directly the planning situation.

3.2.1. Method

Subjects

Because the reflection on context variables implies an acquintance with the real classroom, experienced teachers were recruited. The nine teachers (6 males and 3 females) all taught in primary schools.

Procedure

Each teacher was invited to write down one usual lesson plan to enable the investigator the preparation of each in-depth interview. However, three teachers did'nt deliver a lesson plan and the others wrote very sketchy plans. Consequently, emphasis was laid on the retrospection session which was audio taped and recorded in protocols. The material has been elaborated as follows. First, all the protocols were analyzed and the passages selected where teachers reflect upon the context variables. Second, this information was classified into the three categories deduced from the literature: pupils, curriculum and broader teaching context. Third, the data were interpreted and compared with the outcomes of the literature.

3.2.2. Results

Pupils

The level of interest, motivation and abstraction as well as the foreknowledge of individual pupils were frequently reported. In some cases, these variables were taken into account for decision making about individualization and differentiation within the classroom.
Not only the individual pupils, but also the whole class was conceived of as a context variable. The composition as well as the interaction patterns were important for further decisions. However, each teacher selected information from the environment which fitted into her subjective theory of teaching and the underlying values. Teachers were not only steered by the context, but they also manipulated context variables in order to adjust the situation to their needs.

Curriculum

Almost all teachers indicated the influence of the curriculum on their teaching plans. They experienced the content as well as the objectives in the curriculum as very influential on their planning whereas handbooks were conceived of as important tools. The handbook was the more important the level of difficulty raised. When a teacher

perceived the subject matter as difficult, she leant more heavily on the instructions in the handbook. The higher the difficulty, the more directing was the handbook. The uncertainty of teachers was thus reflected in a more need for structure and guidance.

The broader teaching context

Within this category, diverging aspects of the teaching-learning situation were mentioned. The physical environment, the available tools and learning materials, together with the organizational and administrative aspects determined many decisions about teaching.
Colleagues from the same or higher grades had an impact on the planning because of the necessary horizontal and vertical coordination. School directors and inspectors were very influential and their wishes about lesson content, teaching strategies and extra-curricular activities were taken very seriously. On the contrary, parents seldom were mentioned as information sources important for the planning decisions. Only when a concrete or heavy problem is signalized by a particular parent the teacher tried to take it into account, although it was very difficult to describe exactly what the concrete impact on the planning was.

In short, the teacher defines what from the situation she allows to enter the planning, with as a consequence the strong reduction of the complex environment. Teaching seems not as much the reflection of the complexity of the context variables. On the contrary, only that parts of reality are allowed in the planning activity which are congruent with the reduced teaching model teachers have in mind.

4. Post-interactive reflections of teachers

Since research on teacher thinking has started, the differentiation of cognitive processes into three separate phases was taken for granted. While many investigators

focused on the pre-interactive phase and less on the interactive, very few tackled the post-interactive cognitive processes. In this study the question was raised if and to what degree teachers reflected after the lesson is taught and how their reflections influenced future teaching.

4.1. Data from the literature

What teachers do after their lessons can be qualified as 'evaluation', and "refers to the phase of teaching where teachers assess their plans and accomplishments and so revise them for the future" (Shavelson & Stern, 1981, p.471). McKay & Marland (1978) use the term "reflection" as a category of interactive thoughts, meaning "units in which the teacher is thinking about past aspects of, or events in, the lesson other than what he has done". They limit reflection to the cognitive processes of teachers that concern their not realized teaching behaviors. The definition of Clark & Peterson (1985) is more neutral and efficient, speaking about " postinteractive thoughts".
We will use the term " post-interactive reflections" as a label for all the information processing activities of the teacher after a lesson or a broader unit. If teachers use explicitly criteria for determining the quality of their past behavior, we speak then about evaluation.
We adapted the units of analysis used by Yinger (1978) in his study of teachers' planning into the following categories: lesson moment, lesson, day, week, month, tri/semester, year, career.

4.2. Data from the descriptive-empirical research

Because of the lack of empirical studies on the topic at hand, we explored the post-interactive reflections in a descriptive-empirical way.

4.2.1. Method

Subjects

As was the case with the earlier studies, primary school teachers were asked for collaboration. Twelve experienced teachers (9 females, 3 males) were recruited. Their teaching experience varied between 3 and 32 years and with a mean score of 19 years.

Procedure

The teachers first received a letter in which the aims and procedures of the research were clarified and an orientation on the reflection was given. They were also invited to illustrate some thoughts with very concrete instances. Last, they were asked whether their after-lesson thoughts influenced future teaching. After the written preparation, an in-depth interview was organized with each teacher. The session was audio recorded and afterwards laid down in written protocols.
The material was scrutinized in a recurrent, cyclical way. Two types of data were gathered: information from a broad retrospection and from the concrete instances. Due to the limited space we will report both types of information together.

4.2.2. Results

First, teachers differed clearly as to the frequency and quality of their post-interactive reflections. This applied both to the content and the systematics of the reported thoughts.
Second, post-interactive reflection was instigated mainly by negative experiences: the gap between expected and realized behaviors was the main source. However, when teachers gave concrete instances of reflections, the positive thoughts came to light because they intended to repeat successful behaviors. In every way, teachers reflect upon striking experiences. What makes an event striking or not strongly depends upon subjective theories, and it seems difficult to discover an objective measure for the identification of reflection topics.

Third, the following categories of post-interactive reflection were reported.

- Individual pupils, mostly the weakest or brightest. Sometimes the reflection focused at pupils' personal problems or indiscipline.
- The class as a group, with the supposed capacities, level of knowledge and, to a less degree, the level of motivation, interest and involvement.
- The own teaching behavior, mainly if it had a visible negative or surprising positive effect. Less frequent but the more intensive were reflections on overreaction, for example exaggerated punishment.
- Extra-scholar contacts with parents or intra-scholar relationship with colleagues, insoector, director in which broader aspects of the teachers' job are reflected, such as the lack of cooperation.
- The lesson organization, mainly how a higher amount of content should be managed during an equal lesson-time.
- The lesson content, for all if it has been too difficult.

All the reflections already mentioned, referred to isolated thoughts. Sometimes however, teachers combined several elements. For example, the reflection upon an individual pupil was followed by a diagnosis which led to the intention to solve the problem. Here, the link between post-interactive reflection and plans for future behavior was evident and, as a consequence, the boundaries between the phases of teaching were fading.
As to the question what time units teachers used in their post-interactive reflection, it appeared that some objectively interesting units were not used. Teachers reflected less in terms of chronological units than in substantial topics. Only if some topics corresponded with a time unit (day, week, trimester) teachers used the chronological terms. Thus, the chronological categorization of teaching events was subordinated to the thematic one. Nevertheless, there has been observed some affinity between units of time and concrete retrospection objects. Difficulties with a single pupil, for instance, mostly referred to a lesson moment. Reflections about the teacher

herself, the class or the lesson content was normally linked with a whole lesson, while post-interactive thoughts about parents, colleagues, inspectors or schoolleader covered a longer period.
The impact of post-interactive reflections on future teaching mainly was reported in view of the lesson content. Teachers compared the actual level of classroom performance with that of the former class groups, estimated both progress and retardation and generated new plans. Sometimes, experiences of success with one pupil were generalized to the group of next year: the teacher intended for example to explain next time as she did succesfully this year or to use identical illustrations as to reduce the level of difficulty.

5. Discussion

The four studies reported above brought some striking results to light. We briefly will mention them, grouped into three categories: the substantial results, the methodological questions and the theoretical value.

5.1. Substantial results

The impact of the studies depends among others upon the restrictions of the research done. Small samples of (student-) teachers, a limited repertoire of research techniques, the broad and open research questions as well as the way of analyzing the material led to conclusions which are neither exhaustive nor conclusive.
The research started from the expectation that a description of the essential variables in the complex teaching activity is possible. The option for a descriptive approach is very properly if one holds in mind the vast amount of prescriptive models without any empirical support. Logical constructs must be falsified by their psycho-logical counterparts.
The most salient outcomes were the following.
First, each individual teacher shows a very peculiar way of perceiving the essential variables of teaching, which

influence in turn and at least to a certain degree, the interactive behavior. Here, the lack of a well defined "task environment" is evident. Despite of thousands of studies on teaching, we lack still a well elaborated conceptual framework. This shortage leads to the fact that individual teachers can fill out their function as they like: all a teacher does is called "teaching".

Second, it was difficult to detect the essential features of teaching only from a descriptive entry. That good teaching is influenced by both teachers' cognitive processes and observable behavior is well known. The question, however, is what precisely these effective cognitive processes and behaviors are en how they interact. If description is not sufficient, other approaches must be introduced. After a tradition in which external behavior almost exclusively was researched (process-product studies), the cognitive approach almost exclusively focused on covert processes. It seems to us urgent to combine the two approaches in order to bridge the gap between cognition and action. Moreover, supplementary to the description of what teachers spontaneously think and do, more experimental research designs are needed, for example to establish a well defined task environment and to look what aspects of the teaching task were transformed into the problem space.

Third, teachers seldom handle explicit criteria for the evaluation of their own teaching behavior. Teachers, at least in our study, stopped the search for lesson content when a sufficient amount of information was gathered. They never asked questions about the quality or the relevance of the information. This observation allows us to hypothesize that most of teachers' thinking and behavior rests on routines and automated reactions. This is not a negative statement if the routines result from a steadily abbreviation of originally well controlled 'good' teaching thoughts and actions, as is the case with "experts".

Fourth, it became questionable if the distinction between the pre-interactive, interactive and post-interactive phase is sufficient relevant for the study of complex teaching. It is evident that teachers follow a chronological course of activity: before, during and after the classroom

interaction. But this classification is not the only possible one. It is well conceivable to focus on more substantial units, like for example the lesson content. It seems interesting to look at the lesson content as taught in the real classroom and to investigate from there all the important determinants by which the definite or real content was influenced. For the solution of this question, we need both classroom observation and process research. By doing this, we probably will avoid the centrifugal tendency in research, which splits into segments (chronological or others) the meaningful wholeness of teaching.

5.2. Methodological questions

The four studies reported above used one or another form of retrospection, supplemented with concrete illustrations and external analysis of protocols.
The following conclusions are noteworthy.
First, because the studies started when little methodological experience was available, the approach was very open and tentative. It was assumed that for the study of teachers' cognitive processes we needed self reporting techniques. Moreover, through the recruitment of experienced teachers we expected to gather information on expert behavior and good teaching. However, the label "experienced" was multi-interpretable and consequently irrelevant for insight into "good teaching".
Second, in all studies attention is paid to the ecological validity. The research was done during the usual schooltime and in ordinary classrooms with real pupils. Nevertheless, the ecological validity was not optimal. Teachers participated in a voluntary way, knew that the lesson was videotaped, had specific opinions about the researcher's expectations, avoided disturbing or uncertain situations, etc.
Third, the retrospection method was not very reliable when teachers had to situate their cognitive processes in the time. That the retrospection took place after both

pre-interactive and interactive teaching, made the clear distinction between both phases difficult. On the other hand, if teachers retrospected immediately after the lesson preparation, another inconvenience came to light: they were highly influenced during the interaction by the retrospective material about the planning.
Fourth, the control of the retrospection material by external analyses seemed very interesting. Because teachers do not control all the elements in their thinking process, some discrepancy between planned and realized behavior can occur. The more concrete retrospection can be, the more precise the wording is, as has been observed in the fourth study with the illustrations teachers were asked to give. Moreover, teachers did not use a scientific terminology, but a non-professional language, speaking about their 'children' who are weak or bright, enjoy the work, etc.
Fifth, the free retrospection by the teacher limits to a high degree the description of the flow of teaching. They all reflected upon some discrete aspects of the interactive situation and loosed continuity. Moreover, the video registration seemed to influence their selection of retrospection points. Teachers were more influenced by striking images than by the research question about their thinking process.
Sixth, because retrospection is used, the results contain a very high level of rationality. Teachers seldom referred to routines, but defined them negatively as " I do'nt know why this happens"

5.3. Theoretical value

The studies were not embedded in a clear theoretical framework. Only some basic assumptions were made explicit: teaching is an intentional activity in the complex environment and teachers are information processors, perceiving, selecting and interpreting internal and external information. The observable behavior is only fully comprehensible if the teacher revealed the "why" of her activity. Indeed, the same observable behavior can be instigated by different intentions. The choice of groupwork,

for example, can follow from pragmatic, organizational or from didactical intentions. On the other hand, observable behavior can deliver interesting information unknown by the teacher herself, because not all the intended behavior is realized. Many teaching activities are steered by the situation and it is only after a profound and external analysis that the determining variables will be discovered. The teachers were mostly directed by the molar aspects of behavior, which was afterwards filled out with more concrete behaviors. Teaching is thus a hierarchical activity, meaningful organized into different units of behavior. For the theoretical refinement it seems necessary to gain insight into the most meaningful categories of teaching, which are often the largest ones.

The methodological emphasis on teacher thinking may not lead to an exclusively rational theory of teaching. Routines are very realistic components of teaching as are "trial and error" behaviors.

All the characteristics of teaching so far described are not integrated into a consistent teaching model. The problem is a conceptual one, meaning that it is not very clear how we precisely can define the different teaching variables and fit them together into a suitable model

It is our convinction that we have to start from the reality of teaching in order to discover the essential characteristics. An exclusive use of models imported from other scientific domains to study teaching seems not an adequate one. The demarcation of problem-solving, decision-making and information-processing models is a striking example of this difficulty as well as the problems with the extrapolation of outcomes from psychomotoric skilfulness on teaching skills. The core of research on teaching is the question what teaching really means in terms of cognitive processes, observable behavior and situational impact and how these variables fit together in the complex reality of teaching.

6. Epilogue

" No single work advances understanding very far. The aims of a scientific work are limited by the formal character of the theory, by the phenomena it encompasses, by the experimental situations it uses, by the types of subjects it studies, and by the data it gathers. Of course, a theory may speak beyond its initial base - all scientists hope just for that. But science is a series of successive approximations. Not all things can be done at once, and even if one aspires to go far, he must start somewhere. If one aims at covering all of human thinking in a single work, the work will necessarily be superficial. If one aims at probing in depth, then many aspects of the subjects, however important, will be left untouched."

(Newell & Simon, 1979, p.1).

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PUPILS					CURRICULUM								BROAD CONTEXT				
Pupils (in general)	Personality traits	Academic learning	Background	Class as a group	Curriculum (in general)	Content	Objectives	Pedagogical principles	Teaching methods	Media	Evaluation	Organization	Teaching context (in general)	Physical environment	School as organization	Extra-scholar	
		X				X	X	X		X							Bromme (1980)
	X	X	X	X						X				X		X	Clark & Elmore (1979)
X				X		X	X			X				X	X	X	Clark & Yinger (1979;1980)
		X				X											Conklin (1975)
		X		X		X		X									Creemers & Westerhof (1982)
	X			X		X		X		X							Dichanz & Hage (1979)
				X													Doyle (1977)
		X		X		X	X	X		X		X					Gielen (1982)
		X		X	X										X		Jackson (1968)
		X				X	X	X	X	X	X						Klausmeier & Dresden (1962)
		X								X					X	X	Loser (1979)
	X	X	X	X		X	X	X	X	X		X		X	X	X	Lowyck (1978)
		X					X	X			X						Morine (1976)
X		X		X		X	X		X	X					X		Shavelson (1981)
	X	X															Shulman et al. (1975)
	X	X	X	X			X		X	X		X		X	X	X	Smith & Geoffrey (1968)
	X	X				X	X	X	X			X					Stolurow (1971)
		X					X			X	X		X				Taylor (1970)
	X	X	X										X				Veenman (1980)
		X		X	X					X	X			X	X		Yinger (1977)
		X				X	X		X	X	X	X			X		Zahorik (1975)

Table 1. Context variables influencing teaching and planning

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